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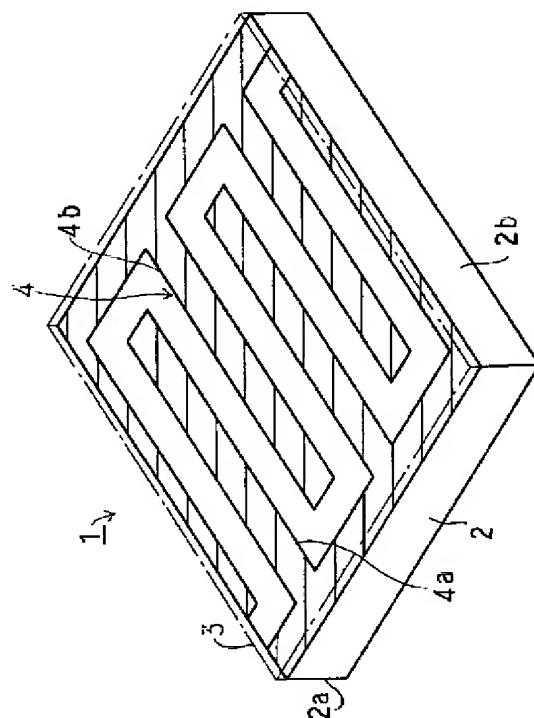
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(54)【発明の名称】 表面波装置

(57)【要約】

【課題】 圧電セラミック材料の電気機械結合係数Kによる制約が少なく、所望とする電気機械結合係数Kを有する表面波基板を用いた表面波装置を得る。

【解決手段】 圧電セラミック基板2上に、圧電セラミック基板2を構成する圧電セラミックよりも横波音速が遅い誘電体材料よりなる誘電体薄膜3を形成して表面波基板を構成し、該表面波基板に少なくとも1つのインターデジタル電極4を構成して成り、BGS波利用した表面波装置1。



**【特許請求の範囲】**

**【請求項1】** BGS波を利用した表面波装置であって、  
圧電セラミック基板と、上記圧電セラミック基板上に形成されており、かつ圧電セラミック基板よりも横波の音速が遅い誘電体材料よりなる誘電体薄膜とを有する表面波基板と、  
前記誘電体薄膜に接するように形成された少なくとも1つのイン터デジタル電極とを備えることを特徴とする、表面波装置。

**【請求項2】** 前記少なくとも1つのインターデジタル電極が、前記圧電セラミック基板と前記誘電体薄膜との間に界面に形成されている、請求項1に記載の表面波装置。

**【請求項3】** 前記誘電体薄膜の上面または下面に形成された金属膜をさらに備える、請求項1または2に記載の表面波装置。

**【請求項4】** 端面反射型表面波共振子である、請求項1～3の何れかに記載の表面波装置。

**【発明の詳細な説明】****【0001】**

**【発明の属する技術分野】** 本発明は、BGS波を利用した表面波装置に関し、より詳細には、大きな電気機械結合係数Kが得られる表面波基板を用いた表面波装置に関する。

**【0002】**

**【従来の技術】** 近年、帯域フィルタや共振子などに、BGS波を利用した表面波装置が種々提案されている（例えば、特開昭51-33582号公報など）。BGS波を利用した表面波装置では、PZTなどの圧電セラミック基板上に励振用にインターデジタル電極が形成されている。

**【0003】** BGS波を利用した表面波装置に限らず、表面波装置では、一般的に、その帯域特性などは、表面波基板の電気機械結合係数Kに依存する。すなわち、電気機械結合係数Kが大きい表面波基板を用いることにより、表面波フィルタを構成した場合には、通過帯域を広げ、挿入損失を小さくすることができる。よって、従来、BGS波を利用した表面波装置においても、電気機械結合係数Kの大きい表面波基板材料が種々検討されてきている（例えば、特開平5-275967号公報、特開平5-226965号公報など）。

**【0004】**

**【発明が解決しようとする課題】** 上述した通り、BGS波を利用した表面波装置の帯域特性は、表面波基板の電気機械結合係数Kに依存する。従って、低挿入損失で、広い帯域特性を得ようとした場合、該帯域特性に応じた電気機械結合係数Kを有する表面波基板を用いる必要がある。

**【0005】** しかしながら、所望とする電気機械結合係

数Kを有する表面波基板が知られていない場合があり、そのような場合には、表面波基板を構成するためのセラミック材料の開発を行わねばならない。ところが、材料開発には多大な労力及び時間を要し、従って、所望とする電気機械結合係数Kを有する表面波基板を用途に応じて迅速に用意にすることはできなかった。

**【0006】** 本発明の目的は、セラミック材料自体の電気機械結合係数Kによる制約が少なく、所望とする電気機械結合係数Kが得られる表面波基板を用いた、BGS波を利用した表面波装置を提供することにある。

**【0007】**

**【課題を解決するための手段】** 請求項1に記載の発明は、BGS波を利用した表面波装置であって、圧電セラミック基板と、上記圧電セラミック基板上に形成されており、かつ圧電セラミック基板よりも横波の音速が遅い誘電体材料よりなる誘電体薄膜とを有する表面波基板と、前記誘電体薄膜に接するように形成された少なくとも1つのインターデジタル電極とを備えることを特徴とする。

**【0008】** 請求項2に記載の発明では、前記少なくとも1つのインターデジタル電極が、前記圧電セラミック基板と前記誘電体薄膜との間に界面に形成されている。また、請求項3に記載の発明では、前記誘電体薄膜の上面または下面に形成された金属膜がさらに備えられる。

**【0009】** なお、本明細書において、上記横波とは、変位の方向と波の伝搬方向とが垂直な波をいうものとする。本願発明者は、上記のように圧電セラミックスの材料開発に長時間を要することに鑑み、種々検討した結果、圧電セラミック基板上に誘電体薄膜を形成してなる表面波基板を用い、さらに該表面波基板において圧電セラミック基板と誘電体薄膜との間にインターデジタル電極を形成すれば、大きな電気機械結合係数Kを得ることができ、さらに誘電体薄膜の膜厚及び材料を調整することにより、所望とする大きな電気機械結合係数Kが得られることを見出し、本発明を成すに至った。すなわち、本発明は、実験的に見出されたものである。

**【0010】** なお、上記圧電セラミック基板を構成する材料については、BGS波を励振し得る限り、特に限定されるものではなく、例えば、LiTaO<sub>3</sub>、LiNbO<sub>3</sub>などの圧電単結晶基板、あるいはチタン酸ジルコン酸鉛系セラミックスのような圧電セラミックスよりなるものを用いることができる。

**【0011】** また、上記誘電体薄膜を構成する材料についても、上記圧電セラミック基板に比べて横波の音速が遅い限り、特に限定されず、例えば、CdSなどの圧電薄膜、ポミニミドなどの有機材料よりなる誘電体薄膜、PbS、Nb<sub>2</sub>O<sub>5</sub>などの無機材料よりなる誘電体薄膜を用いることができる。

**【0012】** 上記誘電体薄膜の厚みについては、該誘電体薄膜の厚みを変更することにより電気機械結合係数K

を変化させることができ、特に限定されるものではない。また、本発明に係る表面波装置は、上記表面波基板と少なくとも1つのインターデジタル電極とを有することに特徴を有するものであり、インターデジタル電極の数や配置等については特に限定されるものではなく、端面反射型表面波共振子、複数のインターデジタル電極を有する表面波フィルタなど、様々な表面波装置に本発明を適用することができる。

### 【0013】

【発明の実施の形態】図1は、本発明の一実施例に係る表面波装置を示す斜視図である。表面波装置1は、圧電セラミック基板2上に、圧電セラミック基板2よりも横波の音速が遅い誘電体薄膜3を形成した構造を有する。すなわち、圧電セラミック基板2と誘電体薄膜3との積層構造により、表面波基板が構成されている。そして、圧電セラミック基板2の上面と誘電体薄膜3の下面との界面に、インターデジタル電極4が形成されている。インターデジタル電極4は、一对のくし歯電極4a, 4bを有する。くし歯電極4a, 4bは、それぞれ、1以上の電極指を有し、互いの電極指が間挿し合うように配置されている。

【0014】ここでは、くし歯電極4a, 4bは、端面反射型表面波共振子を構成するように形成されている。すなわち、複数本の電極指のうち、電極指の延びる方向と直交する方向、最外側に位置する電極指が、圧電セラミック基板2の対向2端面2a, 2bと上面との成す端縁に沿うように形成されている。

【0015】圧電セラミック基板2及び誘電体薄膜3については、前述した各種材料により構成することができる。本実施例では、上記圧電セラミック基板2上に誘電体薄膜が積層されて表面波基板が構成されており、かつインターデジタル電極4が両者の界面に形成されているため、誘電体薄膜3の材料及び厚みを調整することにより、所望とする電気機械結合係数Kを有する表面波基板を構成することができる。これを、図2～図6を参照して説明する。

【0016】まず、圧電セラミック基板として、Pb(Ti, Zr)O<sub>3</sub>からなるものを用い、該圧電セラミック基板上に誘電体薄膜としてCdS薄膜を種々の膜厚で作製してなる表面波基板を用い、図2(a), (b)及び図3(a)及び(b)に示す構造の表面波装置を作製した。図2(a)に示す表面波装置11では、上記実施例の表面波装置1と同様に、圧電セラミック基板2と誘電体薄膜3との界面にインターデジタル電極4が形成されている。また、図2(b)に示す表面波装置12では、圧電セラミック基板2と圧電薄膜3とを積層し、両者の界面にインターデジタル電極4を形成した構造において、さらに誘電体薄膜の上面に金属層5が形成されている。

【0017】図3(a)に示す表面波装置13では、圧

電セラミック基板2上に誘電体薄膜3が形成されており、該誘電体薄膜3上にインターデジタル電極4が形成されている。図3(b)に示す表面波14では、圧電セラミック基板2上に金属層5を介して誘電体薄膜3が形成されており、該誘電体薄膜3上にインターデジタル電極4が形成されている。

【0018】上記表面波装置11～14において、誘電体薄膜の膜厚を種々異ならせサンプルを作製し、その音速を測定し、該音速に基づき、あるいはIDTの動コンダクタンスより電気機械結合係数Kを測定した。結果を図4に示す。

【0019】なお、図4における横軸は、誘電体薄膜3の規格化された膜厚H/λ (Hは誘電体薄膜3の膜厚、λは表面波の波長を示す)を表す。図4から明らかなように、表面波装置11, 12において、大きな電気機械結合係数を得られること、また、誘電体薄膜3の膜厚H/λを変化させることにより、様々な電気機械結合係数Kを有する表面波装置を構成し得ることがわかる。なお、表面波装置14では、BGS波が有効に励振されていないこともわかる。

【0020】従って、図4の結果から、表面波装置11及び12、すなわち圧電セラミック基板2と誘電体薄膜3との界面にインターデジタル電極4を形成すれば、比較的大きな電気機械結合係数Kを得ることができ、かつ様々な電気機械結合係数Kを有する表面波基板を用いた表面波装置を構成し得ることがわかる。

【0021】もっとも、表面波装置13においても、誘電薄膜3の膜厚が薄い領域、すなわち、H/λ=0.015以下の領域で様々な電気機械結合係数Kを有する表面波基板を構成し得ることがわかる。

【0022】よって、本発明に従って、圧電セラミック基板2上に誘電体薄膜3を形成した表面波基板を用いることにより、該誘電体薄膜3の厚みを調整することにより、既存の圧電セラミック基板では得られない電気機械結合係数Kを有する表面波基板を構成し得ることがわかる。

【0023】次に、圧電セラミック基板材料及び誘電体薄膜を種々ことならせ、誘電体薄膜の厚みと電気機械結合係数Kとの関係を調べた。結果を図5及び図6に示す。図5は、圧電セラミック基板としてPb(Ti, Zr)O<sub>3</sub>(横波の音速=2517m/秒、この基板材料を以下、Pb(Ti, Zr)O<sub>3</sub>・Jとする。)を用い、圧電セラミック基板上に種々の材料からなる誘電体薄膜を様々な厚みで形成し、図2(a)に示す表面波装置11を構成した場合の結果を示し、図6は、圧電セラミック基板としてPb(Ti, Zr)O<sub>3</sub>(横波の音速=2580m/秒、この基板材料を以下、Pb(Ti, Zr)O<sub>3</sub>・Kとする。)からなるものを用い、図5に示した場合と同様に様々な誘電体材料よりなる誘電体薄膜を種々の厚みで形成した場合の電気機械結合係数Kの

変化を示す。

【0024】なお、誘電体薄膜材料としては、CdS、ポリイミドを用いた。図5から明らかなように、圧電セラミック基板としてPb(Ti, Zr)O<sub>3</sub>を用いた場合に、上記種々の誘電体薄膜を形成し、さらに厚みを変化させることにより、様々な電気機械結合係数Kを実現し得ることがわかる。特に、図5の結果から、圧電性を有するCdS薄膜を形成した場合、並びにポリイミド膜を形成した場合に、大きな電気機械結合係数Kの得られることがわかる。

【0025】同様に、図6に示す結果から、圧電セラミック材料としてPb(Ti, Zr)O<sub>3</sub>・Kを用いた場合、CdS膜及びポリイミド膜を形成した場合には、大きな電気機械結合係数Kを得ることができ、特に、膜厚H/λが0.08以下では、膜厚の増加に伴って電気機械結合係数Kが増大することがわかる。

【0026】よって、上記のように、圧電セラミック基板上に形成される誘電体薄膜材料及び膜厚を適宜変更することにより、所望とする電気機械結合係数Kを容易に実現し得ることがわかる。

【0027】なお、上記実験に用いた圧電セラミック材料及び誘電体薄膜を構成する誘電体材料の横波音速は下記の表1に示す通りである。

#### 【0028】

【表1】

材 料	横波音速 (m/秒)
PZT・J	2517
PZT・K	2580
CdS	1766
ポリイミド	916
PbS	1751
Nb <sub>2</sub> O <sub>5</sub>	2335

#### 【0029】

【発明の効果】請求項1に記載の発明に係る表面波装置では、圧電セラミック基板上に圧電セラミック基板よりも横波の音速が遅い誘電体材料となる薄膜が形成されて表面波基板が構成されているため、上述した実験結果から明らかのように、音速の遅い誘電体薄膜を構成する

誘電体材料及び誘電体薄膜の膜厚を調整することにより、従来の圧電セラミック基板では得られなかつた様々な電気機械結合係数Kを有する表面波基板を構成することが可能となる。従って、用途や要求特性に応じて、大きな電気機械結合係数Kを有する表面波基板を用いた表面波装置を、迅速に提供することが可能となる。

【0030】請求項2に記載の発明では、IDT電極が、圧電セラミック基板と誘電体薄膜との間の界面に形成されているため、所望とする電気機械結合係数Kを有する表面波基板であって、しかも電気機械結合係数Kの大きな表面波基板を提供することが可能となり、従つて、広帯域の表面波装置を容易に提供することが可能となる。

#### 【図面の簡単な説明】

【図1】本発明の一実施例に係る表面波装置を示す斜視図。

【図2】(a)及び(b)は、本発明に従つて表面波基板及びIDT電極を形成してなる表面波装置を説明するための各模式的断面図。

【図3】(a)及び(b)は、圧電セラミック基板と誘電体薄膜とを積層してなる表面波基板を用いた各表面波装置の断面図。

【図4】図2及び図3に示した表面波装置における誘電体薄膜の規格化膜厚H/λと電気機械結合係数Kとの関係を示す図。

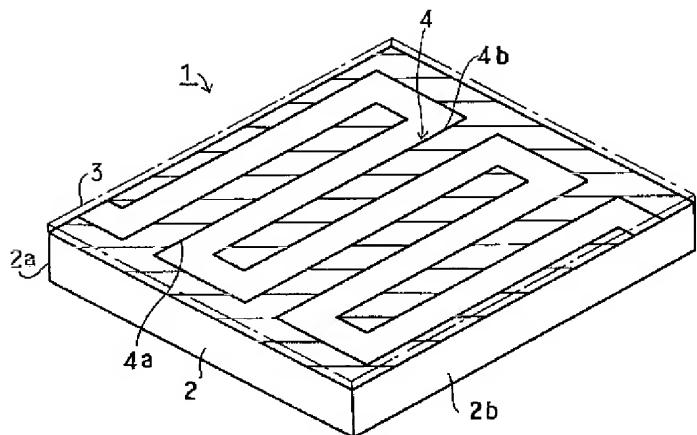
【図5】圧電セラミック基板としてPb(Ti, Zr)O<sub>3</sub>・Jからなるものを用いた場合の、誘電体薄膜材料及びその厚みH/λと電気機械結合係数Kとの関係を示す図。

【図6】圧電セラミック基板としてPb(Ti, Zr)O<sub>3</sub>・Kからなるものを用いた場合の、誘電体薄膜材料及びその厚みH/λと電気機械結合係数Kとの関係を示す図。

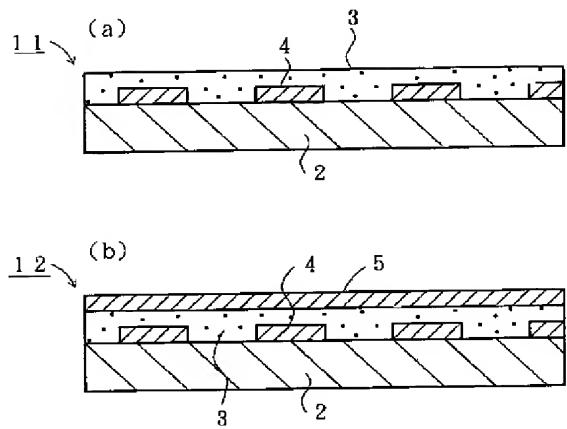
#### 【符号の説明】

- 1…表面波装置
- 2…圧電セラミック基板
- 3…誘電体薄膜
- 4…インターデジタル電極
- 5…金属層
- 11, 12…表面波装置

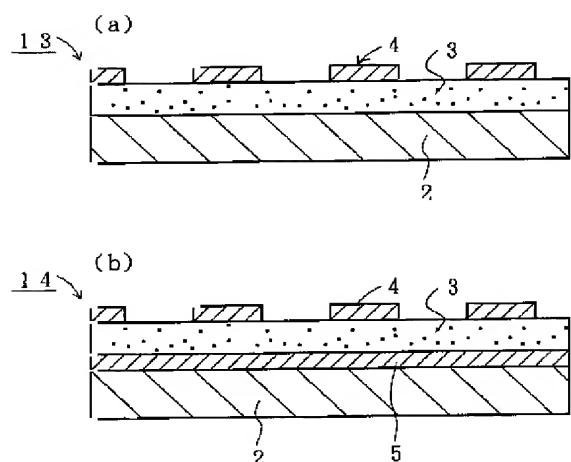
【図1】



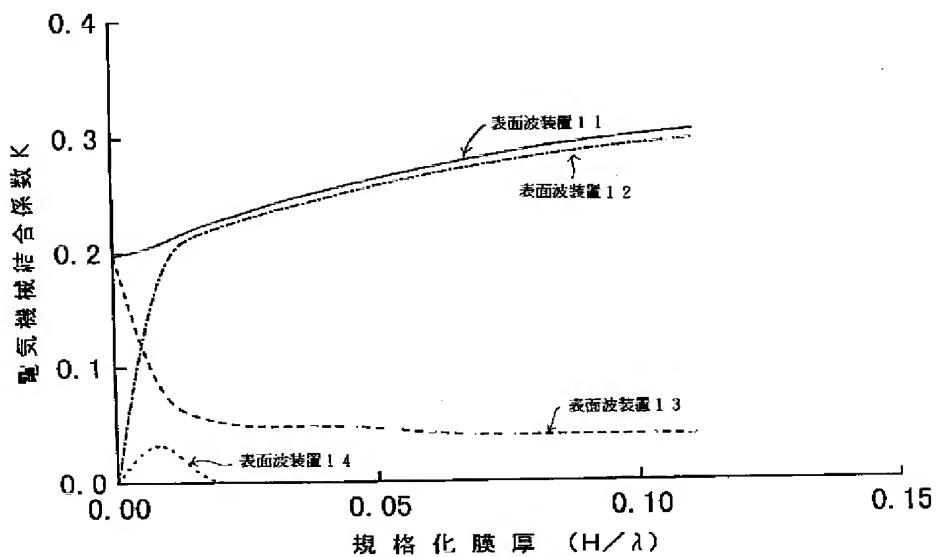
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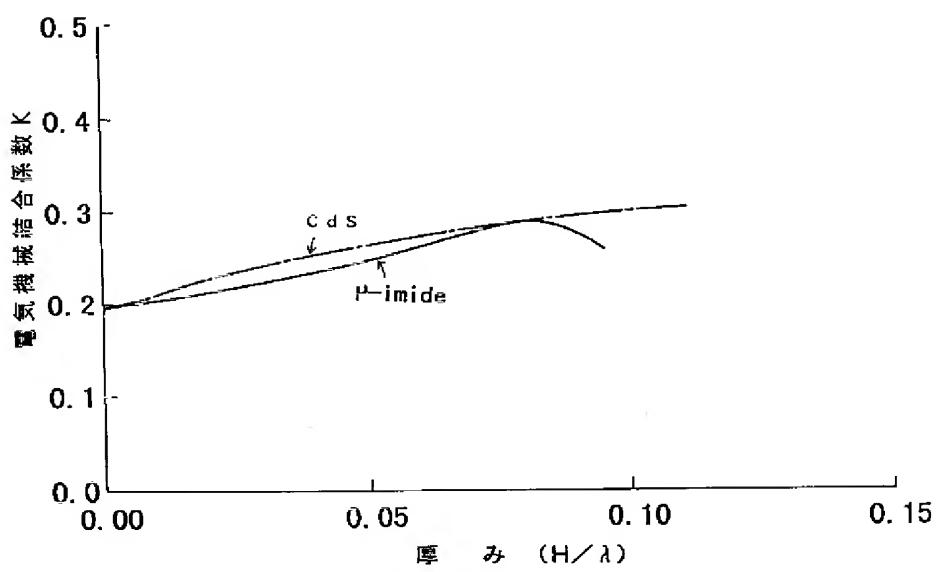
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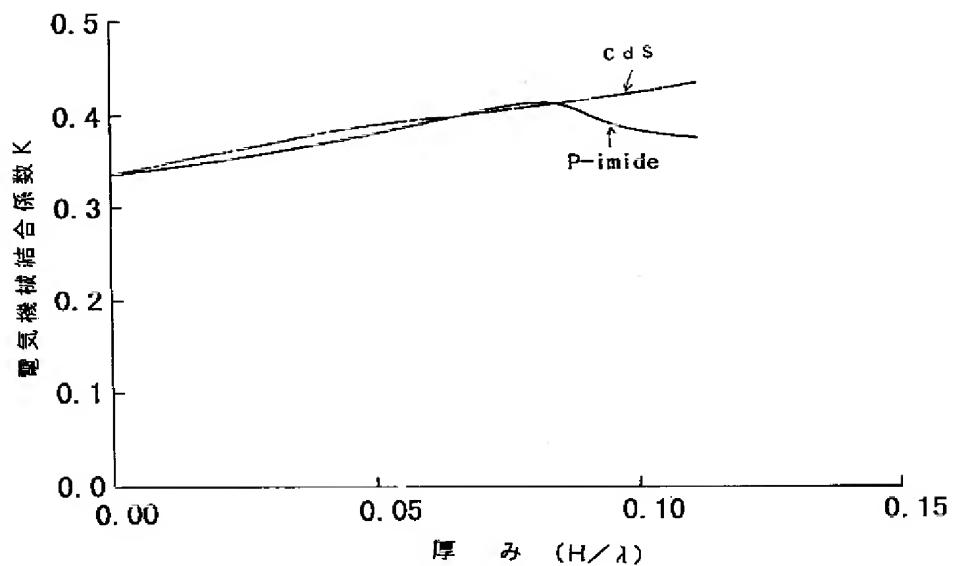
【図4】



【図5】



【図6】



# PATENT ABSTRACTS OF JAPAN

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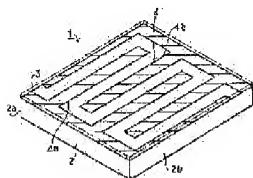
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(21)Application number : 09-277302 (71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 09.10.1997 (72)Inventor : KADOTA MICHIRO

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(54) SURFACE WAVE DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a surface wave device which has various electromechanical coupling coefficients by forming a thin film, made of a dielectric material wherein the sound speed of a transverse wave is faster than in a piezoelectric ceramic substrate and an interdigital electrode which is in contact with it on the piezoelectric ceramics substrate.

SOLUTION: On a piezoelectric ceramics substrate 2, a dielectric thin film 3, wherein the sound speed of a transverse wave is faster than in the piezoelectric

ceramic substrate 2 is formed. Namely, a surface wave substrate is composed of a laminate structure of the both. Further, the interdigital electrode 4 is formed on the boundary surface between the top surface of the piezoelectric ceramics substrate 2 and the reverse surface of the dielectric thin film 3. Comb-teeth electrodes 4a and 4b constitute an end surface reflection type surface wave resonator and electrode finger which are positioned on the outermost sides in the direction orthogonal to the extending direction of the electrode fingers extend along the end edges formed of the two opposite end surfaces 23a and 2b and the top surface of the piezoelectric substrate 2. Then the surface wave substrate, which has a desired electro-mechanical coupling coefficient, can be constituted by adjusting the material and thickness of the dielectric thin film 3.

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## LEGAL STATUS

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rejection or application converted  
registration]

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[Patent number]

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CLAIMS

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[Claim(s)]

[Claim 1] Surface wave equipment characterized by having the surface wave substrate which has the dielectric thin film with which it is surface wave equipment using a BGS wave, and it is formed on the piezo-electric ceramic substrate and the above-mentioned piezo-electric ceramic substrate, and the acoustic velocity of a transverse wave consists of late dielectric materials rather than a piezo-electric ceramic substrate, and at least one INTADEJITARU electrode formed so that said dielectric thin film might be touched.

[Claim 2] Surface wave equipment according to claim 1 with which said at least one INTADEJITARU electrode is formed in the interface between said piezo-electric ceramic substrates and said dielectric thin films.

[Claim 3] Surface wave equipment according to claim 1 or 2 further equipped with the metal membrane formed in the top face or inferior surface of tongue of said dielectric thin film.

[Claim 4] Surface wave equipment given in any of claims 1-3 which are end-face reflective mold surface wave resonators they are.

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## **DETAILED DESCRIPTION**

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### **[Detailed Description of the Invention]**

#### **[0001]**

**[Field of the Invention]** This invention relates to the surface wave equipment using the surface wave substrate with which the more big electromechanical coupling coefficient K in a detail is obtained about the surface wave equipment using a BGS wave.

#### **[0002]**

**[Description of the Prior Art]** In recent years, the surface wave equipment which used the BGS wave for the band-pass filter, the resonator, etc. is proposed variously (for example, JP,51-33582,A etc.). With the surface-wave equipment using a BGS wave, the INTADEJITARU electrode is formed for excitation on piezo-electric ceramic substrates, such as PZT.

**[0003]** Generally not only with the surface wave equipment using a BGS wave but with surface wave equipment, it depends for the band property etc. on the electromechanical coupling coefficient K of a surface wave substrate. That is, when an electromechanical coupling coefficient K constitutes a surface wave filter by using a large surface wave substrate, a passband can be extended and an insertion loss can be made small. Therefore, also in the surface wave equipment using a BGS wave, the surface wave substrate ingredient with a large electromechanical coupling coefficient K has been examined variously conventionally (for example, JP,5-275967,A, JP,5-226965,A, etc.).

[0004]

[Problem(s) to be Solved by the Invention] It depends on the electromechanical coupling coefficient K of a surface wave substrate for the band property of surface wave equipment of having used the BGS wave as mentioned above. Therefore, by the low insertion loss, when it is going to acquire a wide band property, it is necessary to use the surface wave substrate which has the electromechanical coupling coefficient K according to this band property.

[0005] However, the surface wave substrate which has the electromechanical coupling coefficient K considered as a request may not be known, and, in such a case, the ceramic ingredient for constituting a surface wave substrate must be developed. However, the surface wave substrate which has the electromechanical coupling coefficient K which ingredient development takes a great effort and time amount to, therefore is considered as a request was not able to be quickly made preparation according to the application.

[0006] The purpose of this invention has little constraint by the electromechanical coupling coefficient K of the ceramic ingredient itself, and is to offer the surface wave equipment using a BGS wave using the surface wave substrate with which the electromechanical coupling coefficient K considered as a request is obtained.

[0007]

[Means for Solving the Problem] Invention according to claim 1 is surface wave equipment using a BGS wave, and is characterized by having the surface wave substrate which has the dielectric thin film with which it is formed on the piezo-electric ceramic substrate and the above-mentioned piezo-electric ceramic substrate, and the acoustic velocity of a transverse wave consists of late dielectric materials rather than a piezo-electric ceramic substrate, and at least one INTADEJITARU electrode formed so that said dielectric thin film might be touched.

[0008] In invention according to claim 2, said at least one INTADEJITARU electrode is formed in the interface between said piezo-electric ceramic substrates and said dielectric thin films. Moreover, in invention according to claim

3, it has further the metal membrane formed in the top face or inferior surface of tongue of said dielectric thin film.

[0009] In addition, in this specification, the above-mentioned transverse wave shall mean a wave with perpendicular direction and direction of wave propagation of a variation rate. An invention-in-this-application person takes an example by ingredient development of electrostrictive ceramics taking long duration as mentioned above. If an INTADEJITARU electrode is further formed in the interface of a piezo-electric ceramic substrate and a dielectric thin film in this surface wave substrate using the surface wave substrate which comes to form a dielectric thin film on a piezo-electric ceramic substrate as a result of examining many things It came to accomplish a header and this invention for the big electromechanical coupling coefficient K considered as a request being obtained by being able to obtain the big electromechanical coupling coefficient K and adjusting the thickness and the ingredient of a dielectric thin film further. That is, this invention is found out experimentally.

[0010] In addition, about the ingredient which constitutes the above-mentioned piezo-electric ceramic substrate, as long as a BGS wave can be excited, it is not limited and what consists of electrostrictive ceramics like piezo-electric single crystal substrates, such as LiTaO<sub>3</sub> and LiNbO<sub>3</sub>, or the titanic-acid lead zirconate system ceramics can be used.

[0011] moreover, the dielectric thin film which is not limited, for example, consists of organic materials, such as piezo-electric thin films, such as CdS, and POMIIMIDO, as long as the acoustic velocity of a transverse wave is slow also about the ingredient which constitutes the above-mentioned dielectric thin film compared with the above-mentioned piezo-electric ceramic substrate, and PbS and Nb<sub>2</sub>O<sub>5</sub> etc. -- the dielectric thin film which consists of an inorganic material can be used.

[0012] About the thickness of the above-mentioned dielectric thin film, by changing the thickness of this dielectric thin film, an electromechanical coupling coefficient K can be changed and it is not limited especially. Moreover, the

surface-wave equipment concerning this invention does not have the description to have the above-mentioned surface-wave substrate and at least one INTADEJITARU electrode, is limited neither about the number of INTADEJITARU electrodes, nor especially arrangement, and can apply this invention to various surface-wave equipments, such as a surface-wave filter which has an end-face reflective mold surface-wave resonator and two or more INTADEJITARU electrodes.

[0013]

[Embodiment of the Invention] Drawing 1 is the perspective view showing the surface wave equipment concerning one example of this invention. Surface wave equipment 1 has the structure in which the dielectric thin film 3 with the acoustic velocity of a transverse wave slower than the piezo-electric ceramic substrate 2 was formed on the piezo-electric ceramic substrate 2. That is, the surface wave substrate is constituted by the laminated structure of the piezo-electric ceramic substrate 2 and the dielectric thin film 3. And the INTADEJITARU electrode 4 is formed in the interface of the top face of the piezo-electric ceramic substrate 2, and the inferior surface of tongue of the dielectric thin film 3. The INTADEJITARU electrode 4 has the sinking comb electrodes 4a and 4b of a pair. The sinking comb electrodes 4a and 4b have one or more electrode fingers, and they are arranged, respectively so that a mutual electrode finger may put each other in between.

[0014] Here, the sinking comb electrodes 4a and 4b are formed so that an end-face reflective mold surface wave resonator may be constituted. That is, the direction where an electrode finger is prolonged among two or more electrode fingers, the direction which intersects perpendicularly, and the electrode finger located in an outermost part are formed so that the edge of opposite 2 end-face 2a of the piezo-electric ceramic substrate 2, 2b, and a top face to accomplish may be met.

[0015] About the piezo-electric ceramic substrate 2 and the dielectric thin film 3, it can constitute with the various ingredients mentioned above. Since the

laminating of the dielectric thin film is carried out on the above-mentioned piezo-electric ceramic substrate 2, and the surface-wave substrate is constituted and the INTADEJITARU electrode 4 is formed in both interface, the surface-wave substrate which has the electromechanical coupling coefficient K considered as a request can consist of this examples by adjusting the ingredient and thickness of the dielectric thin film 3. This is explained with reference to drawing 2 - drawing 6 . [0016] first -- as a piezo-electric ceramic substrate -- Pb(Ti, Zr) O<sub>3</sub> from -- the surface wave equipment of the structure shown in drawing 2 (a), (b), drawing 3 (a), and (b) was produced using the surface wave substrate which comes to produce a CdS thin film by various thickness on this piezo-electric ceramic substrate as a dielectric thin film using what becoming. With the surface wave equipment 11 shown in drawing 2 (a), the INTADEJITARU electrode 4 is formed in the interface of the piezo-electric ceramic substrate 2 and the dielectric thin film 3 like the surface wave equipment 1 of the above-mentioned example. Moreover, with the surface wave equipment 12 shown in drawing 2 (b), the laminating of the piezo-electric ceramic substrate 2 and the piezo-electric thin film 3 is carried out, and the metal layer 5 is further formed in the top face of a dielectric thin film in the structure which formed the INTADEJITARU electrode 4 in both interface.

[0017] With the surface wave equipment 13 shown in drawing 3 (a), the dielectric thin film 3 is formed on the piezo-electric ceramic substrate 2, and the INTADEJITARU electrode 4 is formed on this dielectric thin film 3. In the surface wave 14 shown in drawing 3 (b), the dielectric thin film 3 is formed through the metal layer 5 on the piezo-electric ceramic substrate 2, and the INTADEJITARU electrode 4 is formed on this dielectric thin film 3.

[0018] In the above-mentioned surface wave equipments 11-14, various thickness of a dielectric thin film was changed, the sample was produced, the acoustic velocity was measured, and the electromechanical coupling coefficient K was measured from the \*\* conductance of IDT based on this acoustic velocity. A result is shown in drawing 4 .

[0019] In addition, the axis of abscissa in drawing 4 expresses thickness  $H/\lambda$  ( $H$  shows the thickness of the dielectric thin film 3, and  $\lambda$  shows the wavelength of a surface wave) by which the dielectric thin film 3 was standardized. In the surface wave equipments 11 and 12, that a big electromechanical coupling coefficient can be obtained and by changing thickness  $H/\lambda$  of the dielectric thin film 3 show that the surface wave equipment which has various electromechanical coupling coefficients  $K$  can be constituted so that clearly from drawing 4 . In addition, with surface wave equipment 14, it also turns out that the BGS wave is not excited effectively.

[0020] Therefore, it turns out that the surface wave equipment using the surface wave substrate which can obtain the comparatively big electromechanical coupling coefficient  $K$ , and has various electromechanical coupling coefficients  $K$  can be constituted from a result of drawing 4 if the INTADEJITARU electrode 4 is formed in an interface with the surface wave equipments 12 [ 11 and ] 2, i.e., a piezo-electric ceramic substrate, and the dielectric thin film 3.

[0021] But also in surface wave equipment 13, it turns out that the surface wave substrate with which the thickness of a dielectric film 3 has various electromechanical coupling coefficients  $K$  in a thin field, i.e., the field not more than  $H/\lambda = 0.015$ , can be constituted.

[0022] Therefore, by adjusting the thickness of this dielectric thin film 3 shows that the surface wave substrate which has the electromechanical coupling coefficient  $K$  which is not obtained can be constituted from an existing piezo-electric ceramic substrate by using the surface wave substrate in which the dielectric thin film 3 was formed on the piezo-electric ceramic substrate 2, according to this invention.

[0023] next, a piezo-electric ceramic substrate ingredient and a dielectric thin film -- versatility -- alias -- accustom -- the thickness of a dielectric thin film and relation with an electromechanical coupling coefficient  $K$  were investigated. A result is shown in drawing 5 and drawing 6 . Drawing 5 is  $Pb(Ti, Zr)O_3$  (acoustic velocity of a transverse wave = a second 2517m /) as a piezo-electric ceramic

substrate. this substrate ingredient is hereafter set to Pb(Ti, Zr) O<sub>3</sub> and J. It uses, the dielectric thin film which consists of various ingredients is formed by various thickness on a piezo-electric ceramic substrate, and the result at the time of constituting the surface wave equipment 11 shown in drawing 2 (a) is shown.

Drawing 6 It is Pb(Ti, Zr) O<sub>3</sub> (2580m /and this substrate ingredient are hereafter set to Pb(Ti, Zr) O<sub>3</sub> and K a second.) as a piezo-electric ceramic substrate.

[ Acoustic velocity of a transverse wave = ] from -- change of the electromechanical coupling coefficient K at the time of forming the dielectric thin film which consists of various dielectric materials like the case where it is shown in drawing 5 by various thickness using what becoming is shown.

[0024] In addition, CdS and polyimide were used as a dielectric thin film material. When Pb(Ti, Zr) O<sub>3</sub> are used as a piezo-electric ceramic substrate so that clearly from drawing 5 , by forming the above-mentioned various dielectric thin films, and changing thickness further shows that various electromechanical coupling coefficients K can be realized. When the CdS thin film which has piezoelectric is especially formed from the result of drawing 5 and the polyimide film is formed in a list, it turns out that the big electromechanical coupling coefficient K is obtained.

[0025] Similarly, when Pb(Ti, Zr) O<sub>3</sub> and K are used as a piezo-electric ceramic ingredient and the CdS film and the polyimide film are formed from the result shown in drawing 6 , the big electromechanical coupling coefficient K can be obtained and it turns out especially that an electromechanical coupling coefficient K increases [ thickness H/lambda ] with the increment in thickness or less by 0.08.

[0026] Therefore, by changing suitably the dielectric thin film material and thickness which are formed on a piezo-electric ceramic substrate as mentioned above shows that the electromechanical coupling coefficient K considered as a request can be realized easily.

[0027] In addition, the transverse-wave acoustic velocity of the dielectric materials which constitute the piezo-electric ceramic ingredient and dielectric thin film which were used for the above-mentioned experiment is as being shown in

the following table 1.

[0028]

[Table 1]

材 料	横波音速 (m/秒)
PZT・J	2 5 1 7
PZT・K	2 5 8 0
CdS	1 7 6 6
ポリイミド	9 1 6
PbS	1 7 5 1
Nb <sub>2</sub> O <sub>5</sub>	2 3 3 5

[0029]

[Effect of the Invention] It becomes possible to constitute the surface wave substrate which has various electromechanical coupling coefficients K which were not obtained from a conventional piezo-electric ceramic substrate by adjusting the thickness of the dielectric materials which constitute the late dielectric thin film of acoustic velocity, and a dielectric thin film so that clearly from the experimental result mentioned above, since the thin film with which the acoustic velocity of a transverse wave consists of a piezo-electric ceramic substrate from late dielectric materials is formed on a piezo-electric ceramic substrate and the surface wave substrate consists of surface wave equipment concerning invention according to claim 1. Therefore, it becomes possible to offer quickly the surface wave equipment using the surface wave substrate which has the big electromechanical coupling coefficient K according to an application or demand characteristics.

[0030] It is the surface wave substrate which has the electromechanical coupling coefficient K considered as a request in invention according to claim 2 since the IDT electrode is formed in the interface between a piezo-electric ceramic substrate and a dielectric thin film, and it becomes possible to become possible to offer a surface wave substrate with an electromechanical coupling coefficient K big moreover, therefore to offer the surface wave equipment of a broadband easily.

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[Translation done.]

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#### **DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] The perspective view showing the surface wave equipment concerning one example of this invention.

[Drawing 2] (a) And (b) is each typical sectional view for explaining the surface wave equipment which comes to form a surface wave substrate and an IDT electrode according to this invention.

[Drawing 3] (a) And (b) is the sectional view of each surface wave equipment which used the surface wave substrate which comes to carry out the laminating of a piezo-electric ceramic substrate and the dielectric thin film.

[Drawing 4] Drawing showing the relation of the standardization thickness  $H/\lambda$  of a dielectric thin film and the electromechanical coupling coefficient K in the surface wave equipment shown in drawing 2 and drawing 3 .

[Drawing 5] Drawing showing the relation between a dielectric thin film material, and its thickness  $H/\lambda$  and electromechanical coupling coefficient K at the time of using what consists of  $Pb(Ti, Zr) O_3$  and J as a piezo-electric ceramic substrate.

[Drawing 6] Drawing showing the relation between a dielectric thin film material,

and its thickness  $H/\lambda$  and electromechanical coupling coefficient  $K$  at the time of using what consists of  $Pb(Ti, Zr)O_3$  and  $K$  as a piezo-electric ceramic substrate.

[Description of Notations]

- 1 -- Surface wave equipment
- 2 -- Piezo-electric ceramic substrate
- 3 -- Dielectric thin film
- 4 -- INTADEJITARU electrode
- 5 -- Metal layer
- 11 12 -- Surface wave equipment

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[Translation done.]

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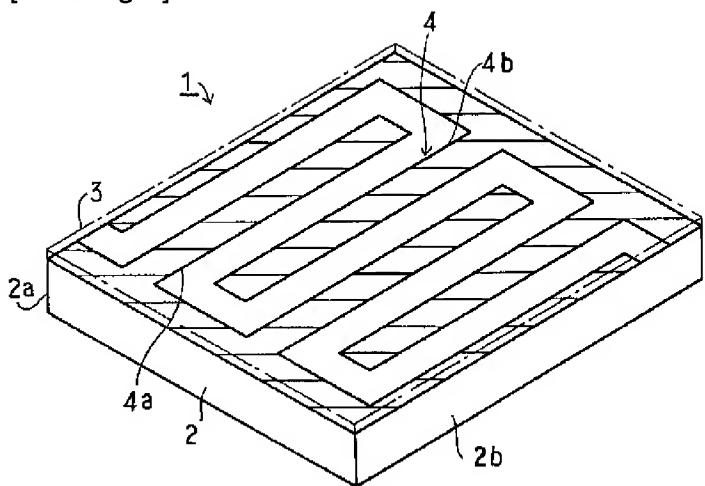
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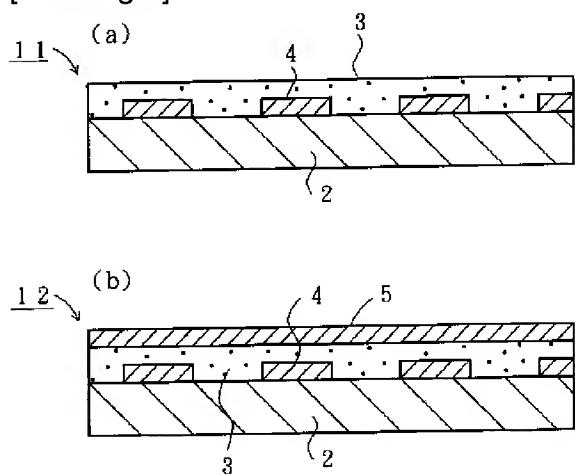
DRAWINGS

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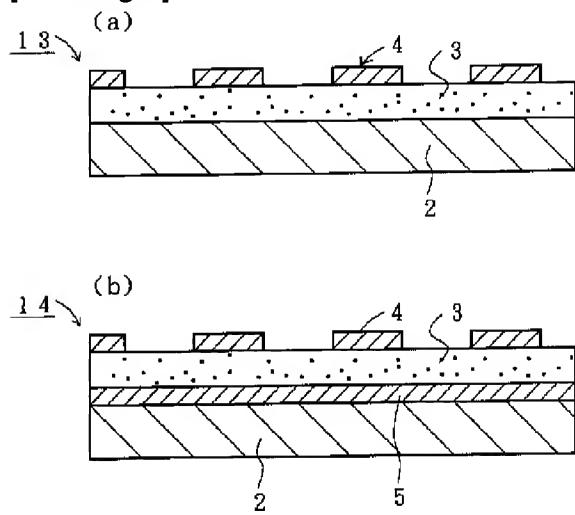
[Drawing 1]



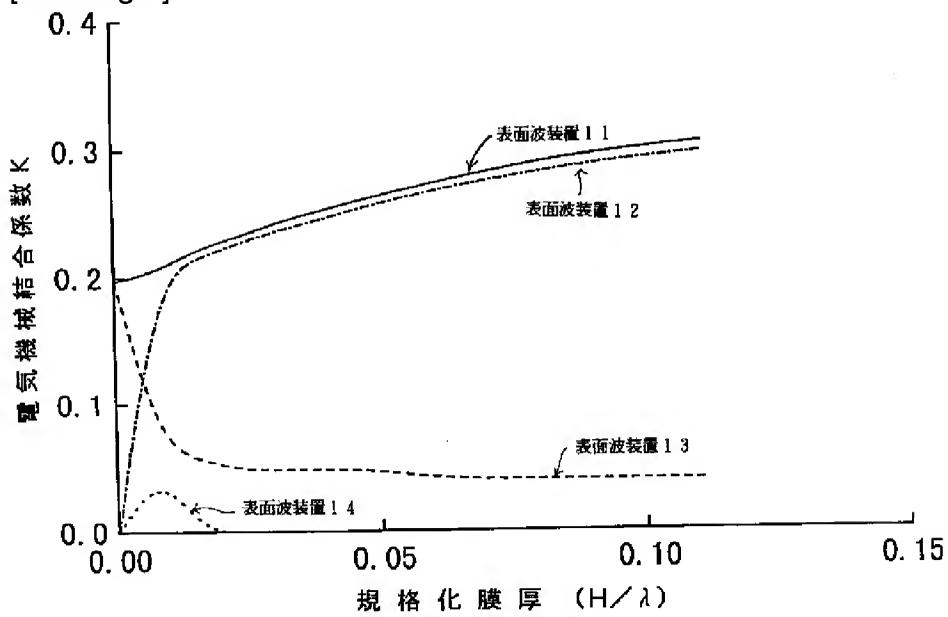
[Drawing 2]



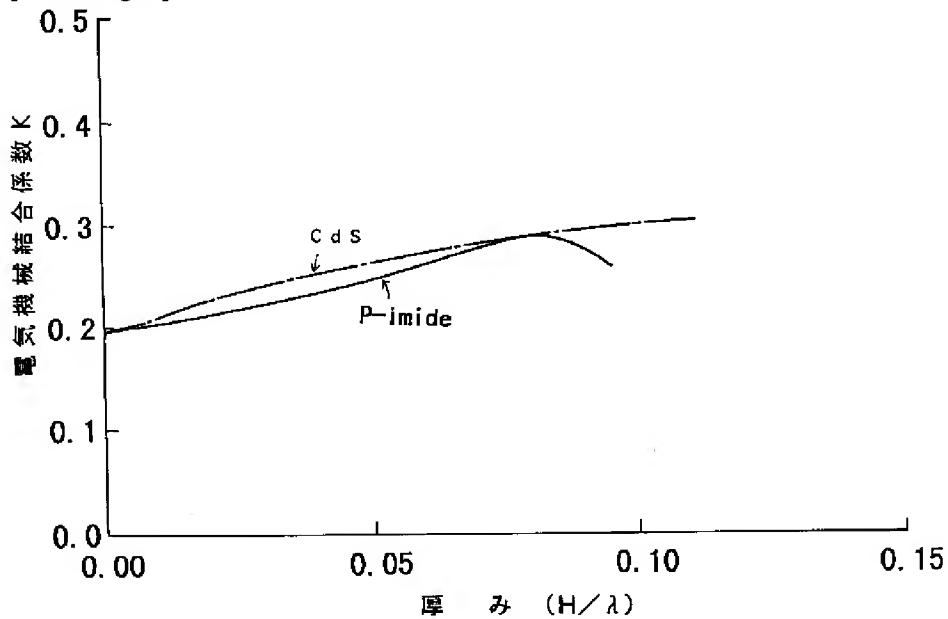
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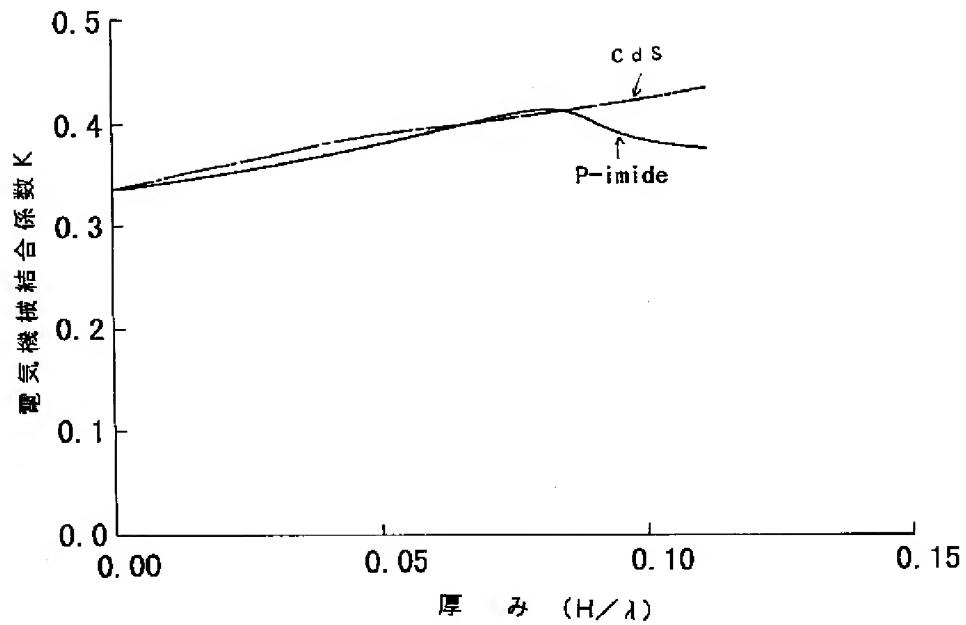
[Drawing 4]



[Drawing 5]



[Drawing 6]



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